Apparatus for thermally conditioning objects

BACKGROUND OF THE INVENTION (Cancel + Underline)

The invention relates to an apparatus for thermally conditioning objects, in particular vehicle bodies, comprising

a) a housing;

b) at least two thermally conditioning facilities which are arranged parallel in their operation, are accommodated in the housing and each comprise

ba) a tunnel-like useful space, in which the objects can be impinged by thermally conditioned air;

bb) a conveying system, by which the objects can be moved through the useful space.

The term "thermally conditioning" is used in the present case as a generic term for all ways in which the temperature of the air by which objects are to be impinged is adjusted to a specific value. Thus, "thermally conditioning" can mean, for example, "heating", which is of importance particularly when the apparatus is designed as a drier. However, "thermally conditioning" can also be "cooling" if the objects are to be brought to a lower temperature.

Apparatuses of the type mentioned at the outset are known from the market in the automotive industry, where painted vehicle bodies or body components are to be dried or cooled. To increase the drying or cooling capacity, a

plurality of parallel-arranged thermally conditioning facilities, i.e. drying or cooling facilities, are frequently employed, these being guided either in each case as "individual tubes" through separate housings or, lying one beside the other, through one and the same housing. However, the space requirement of these known apparatuses is relatively high.

SUMMARY OF THE INVENTION

The object of the present invention is to configure an apparatus of the type mentioned at the outset such that it better meets the constructional conditions at the place where it is to be installed.

This object is achieved according to the invention in that

c) the at least two thermally conditioning devices are arranged one above the other in the housing, substantially over the same floor area.

With the present invention it is recognised that the "valuable commodity" at the place of installation of the apparatus is less the constructional height than the floor area. By arranging, in accordance with the invention, the thermally conditioning facilities not one beside but one above the other in the housing, floor area is saved for a given throughput. The arrangement of the plurality of thermally conditioning facilities one above the other additionally enables the operating principle of the so-called "A-lock", which is already employed in known driers, to be utilised or enhanced.

Particularly simple constructionally is that configuration of the invention in which the air path on which the

thermally conditioned air flows to a first thermally conditioning facility leads through a second thermally conditioning facility. It is thus possible to save on air ducts, since part of the air path to the first thermally conditioning facility is provided by the second thermally conditioning facility.

If a permanent air connection exists between the at least two thermally conditioning facilities, both thermally conditioning facilities must always be operated simultaneously and in parallel. Adaptation to the particular temperature demand, i.e. a change of the capacity of the apparatus, is permitted by that configuration of the invention in which there is provided in the air path a device by which the passage of thermally conditioned air from the second thermally conditioning facility into the first thermally conditioning facility can be interrupted if required. This apparatus can therefore be run at two different capacities: at a larger capacity, in the case of which both thermally conditioning facilities are in operation, and at a smaller capacity, which corresponds to the capacity of that, second thermally conditioning facility through which the air path leads first of all.

In the simplest case, the connection in question can be interrupted manually by an appropriate part which is inserted into the air path. For example, a grating, through which the air flows from the second thermally conditioning facility into the first thermally conditioning facility, can be manually exchanged for a closed metal plate.

It is more convenient if the device for interrupting the air path is a controllable flap or a closable louvre.

If the at least two thermally conditioning facilities at least regionally divide the air path on which the air is discharged from the useful spaces, again a reduction of the outlay on apparatus, in particular of the air ducts required, is possible.

Even greater operating flexibility is permitted by an exemplary embodiment of the invention in which the air path on which the thermally conditioned air flows to the first thermally conditioning facility is independent of the air path on which the thermally conditioned air flows to the second thermally conditioning facility. For then it is possible to run the apparatus either at the total capacity of all the individual thermally conditioning facilities, at the capacity of part of the thermally conditioning facilities or else with each thermally conditioning facility individually.

As already mentioned above, the apparatus can be designed as a drier; it then has at least one heating unit for thermally conditioning the air.

It is particularly preferable if the drier according to the invention has the same number of heating units as there are drying facilities. If individual drying facilities within the whole drier are then shut down, a corresponding number of heating units can likewise be stopped, this being associated with considerable energy savings. Moreover, it is possible to use different air temperatures in the different drying facilities within the same drier.

As likewise already mentioned above, the apparatus according to the invention can also be designed as a cooler. In this case, at least one fan is provided, which sucks in fresh air and introduces it as thermally conditioned air into the useful spaces of the cooling facilities. If the cooling effect of the air of the outside atmosphere is not sufficient, at least one cooling unit, which cools the air introduced into the useful spaces of the cooling facilities, can be additionally provided.

BRIEF DESCRIPTION OF THE DRAWING (Center + Underline)

Exemplary embodiments of the invention are explained in more detail below with reference to the drawing, in which:

Figure 1 shows a vertical section, taken perpendicularly to the movement direction of the objects to be dried, through a drier according to the invention, which is valid both for the exemplary embodiment of Figure 2 and that of Figure 3;

Figure 2 shows a section according to line II-II of Figure 1 through a first exemplary embodiment of a drier according to the invention;

Figure 3 shows a section according to line II-II of Figure 1 through a second exemplary embodiment of a drier according to the invention;

Figure 4 shows a vertical section, similar to Figure 1, through a third exemplary embodiment of a drier according to the invention;

Figure 5 shows a section according to line V-V of Figure 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT (Center + Underline)

Reference is made first of all to Figures 1 and 2 which together illustrate a first exemplary embodiment of a drier. The drier comprises a housing 1 which is subdivided by a horizontal intermediate ceiling 3 into two "storeys".

Arranged above the housing 1 is a circulating-air heating unit 25. The air heated by the latter passes via lateral connecting ducts 4, 5 into the upper "storey" of the housing 1 and there respectively into a pressure space 6, 7, adjacent to the lateral outer wall, of a first drying facility provided as a whole with the reference symbol 100. The pressure spaces 6, 7 are bounded inwards by a vertical partition wall 8, 9, in which openings provided with filters 10, 11 are situated. For maintenance of the filters 10, 11 or cleaning of the pressure spaces 6, 7, the latter can be accessed, as indicated schematically in the left-hand pressure space 6.

Formed between the vertical partition walls 8, 9 and the vertical, lateral boundary walls 12, 13 of the useful space 14 of the drying facility 100 is respectively an air distribution space 15 and 16. The heated air passes from the air distribution spaces 15, 16 via nozzles 17, 18 in the side walls 12, 13 into a tunnel-like useful space 14 and impinges there, as indicated by the arrows, on an

object to be dried, in the example illustrated a freshly painted vehicle body 19.

The heated air is then sucked out of the useful space 14 via floor ducts 20, 21 provided with adjustable suction openings and passes back to the circulating-air heating unit 25 via vertical connecting ducts 22, 23 provided on both sides of the housing 1. The circulating-air circuit through the drying facility is thus completed. The connecting ducts 22, 23 cannot be seen directly in Figure 1 as they are hidden by the pressure spaces 6 and 7, and are merely symbolically indicated by the dashed, upward-pointing arrows.

The objects 19 to be dried are transported through the drying facility 100, accommodated in the upper "storey" of the housing 1, perpendicularly to the plane of projection of Figure 1 with the aid of a conveying device 24.

An almost completely identical drying facility 100' is situated beneath the first drying facility 100 in the lower "storey" of the housing 1. This drying facility 100' likewise comprises a useful space 14' with side walls 12', 13' which bound air distribution spaces 15', 16' inwards. The air distribution spaces 15', 16' are connected to the useful space 14' via nozzles 17', 18'. Lying outside the air distribution spaces 15', 16', separated from the latter by vertical partition walls 8', 9', are pressure spaces 6', 7', from which hot air can pass through filters 10', 11' in the partition walls 8', 9' into the air distribution spaces 15', 16'. The heated air is sucked out of the useful space 14' via floor ducts 20', 21' and passes from there into the same vertical connecting ducts 22, 23 which have already

been described above for the drying facility 100 arranged in the upper "storey".

Whereas in the drying facility 100 situated in the upper "storey" the hot air is fed into the pressure spaces 6, 7 by the circulating-air heating unit 25 directly or via the connecting ducts 4, 5, hot air is fed into the pressure spaces 6', 7' of the lower drying facility 100' from the pressure spaces 6, 7 which are assigned to the upper "storey". Gratings 26, 27 are provided in the floors of the two upper pressure spaces 6, 7 for this purpose, via which gratings the hot air can pass into vertical connecting ducts 28, 29, lying to the side of the floor ducts 20, 21, and into the pressure spaces 6', 7' belonging to the lower "storey".

As Figure 2 makes clear, what has been described above is only a segment of a complete drier. Further, substantially identically designed segments adjoin the illustrated segment on the left and right thereof in Figure 2. At most, these segments differ substantially from the central segment in the temperature of the air introduced into the corresponding useful spaces. The conveying systems 24, 24' pass, of course, through all these segments from an inlet lock, arranged at one end of the drier housing, to an outlet lock arranged at the other end of the drier housing; both locks are not illustrated in Figure 2 and fundamentally have a known construction, in particular that of an A-lock.

In the first exemplary embodiment of a drier described above with reference to Figures 1 and 2, the drying facilities 100, 100' situated in the lower and the upper

"storey" of the housing 1 are preferably operated simultaneously. In order to enable the drying facility 100' situated in the lower "storey" to be switched off in the case of a reduced capacity demand of the whole drier, the gratings 26, 27 are to be closed by, for example, manually insertable metal plates. In this case, the air output of the heating unit 25 is adapted to the reduced demand, for example using a frequency converter.

In a second exemplary embodiment, which is now described with reference to Figures 1 and 3, the adaptation to a lower drier capacity demand is effected in a different way. In the description of the first exemplary embodiment, Figure 1 was to be understood as a section according to the line I-I of Figure 2; it is now to be used, in the description of the second exemplary embodiment, as a section according to line I-I of Figure 3.

The exemplary embodiment of Figure 3 is very similar to that of Figure 2; corresponding parts are therefore provided in Figure 3 with the same reference symbols as in Figures 1 and 2. In order to enable the drying facility 100' situated in the lower "storey" of Figure 3 to be switched off in the case of a reduced capacity demand of the whole drier, the following changes have been made compared with the exemplary embodiment of Figure 2:

Two circulating-air heating units 25, 25' are now situated above the housing 1, each of which needs to have only half the air output of the heating unit 25 of the exemplary embodiment of Figure 2. With the same air output, a doubling of the length of the housing 1 would be possible. Both heating units 25, 25' are connected via respective

connecting ducts 4, 4′ and 5, 5′ to the pressure spaces 6, 7 on both sides of the upper useful space 14. Situated in the connecting duct 4′ which is assigned to the circulating-air heating unit 25′ on the right in Figure 3 is a flap 30, by which this connecting duct 4′ can be closed. The same applies correspondingly to the opposite connecting duct 5′. Correspondingly, further flaps 31 have been inserted into the connecting ducts 28, 29 which connect the upper pressure spaces 6, 7 to the lower pressure spaces 6′, 7′, by which flaps these connecting ducts 28, 29 can be closed if required.

In the exemplary embodiment of Figure 3, the upper and lower floor ducts 20, 21, 20′, 21′ do not open into the same connecting duct. Rather, the drying facility 100 situated in the upper "storey" of the housing 1 has its own connecting ducts 22, 23 which lead upwards to the circulating-air heating unit 25 on the left in Figure 3 and end at the level of the horizontal intermediate ceiling 3, while the floor ducts 20′, 21′ of the lower drying facility 100′ open into their own vertically running connecting ducts 22′, 23′ which penetrate through the intermediate ceiling 3 and lead to the circulating-air heating unit 25′ on the right in Figure 3.

The exemplary embodiment illustrated in Figures 1 and 3 is operated as follows:

If the full capacity of the drier is required, both circulating-air heating units 25 and 25′ are used. With the flap 30 open, both circulating-air heating units 25, 25′ blow heated air into the lateral pressure spaces 6, 7 of the upper drying facility 100, part of which air circulates

in the manner already described via the useful space 14 of the upper drying facility 100, is sucked out via the upper floor ducts 20, 21 and is led via the vertical connecting ducts 22, 23 to the first circulating-air heating unit 25 again. The other part of the hot air produced by the two circulating-air heating units 25, 25′ passes through the gratings 26, 27 in the floor of the pressure spaces 6, 7 of the upper drying facility 100 into the two pressure spaces 6′, 7′ of the lower "storey", is circulated via the useful space 14′ there for the purpose of drying the objects 19′ there, is sucked out via the lower floor ducts 20′, 21′ and is led via the vertically running connecting ducts 22′, 23′ upwards to the second circulating-air heating unit 25′.

In contrast, if only a lower drier capacity is required, the drying facility 100′ situated in the lower storey can be shut down as follows: the circulating-air heating unit 25′ on the right in Figure 3 is stopped; the flap 30 is closed, as is the flap 31′. The circulating-air heating unit 25 on the left in Figure 3 remains in operation, however; the air heated by the latter is circulated solely via the upper useful space 14 and dries the objects 19 guided through this space.

Even greater operating flexibility than in the second exemplary embodiment is possible in the third exemplary embodiment of a drier which is described below with reference to Figures 4 and 5. This exemplary embodiment is likewise so similar to the above-described exemplary embodiments that the same reference symbols are used for corresponding parts.

In the exemplary embodiment of Figures 4 and 5, completely independent operation of the two drying facilities 100, 100′ lying one above the other is possible. What is meant by "independent operation" is that each of these drying facilities 100, 100′ on its own or both drying facilities 100, 100′ together can be run at identical or different air temperatures. For this purpose, the following changes are made compared with the exemplary embodiment of Figure 3:

The air heated by the circulating-air heating unit 25′ illustrated at the top on the right in Figure 5 is not introduced directly into the respective pressure spaces 6′ and 7′ of the drying facility 100′ situated in the lower "storey" but via connecting ducts 36, 37 attached laterally to the housing 1. As a result, the two drying facilities 100, 100′ situated respectively in the upper and lower "storey" of the housing 1 are completely uncoupled from one another.

In the above description of Figures 1 to 5, it has been assumed that the apparatus illustrated is a drier in each case. However, the same design can also be employed for coolers; the only change which has to be made for this purpose consists in replacing the respective circulating-air heating units 25, 25′ by cooling units. An apparatus designed as a cooler can, moreover, adjoin an apparatus functioning as a drier, in which case merely a short air lock or a similar device which separates the warmer atmosphere of the drier from the cool atmosphere of the cooler has to be provided between the two apparatuses.

Optionally, a cooling unit can also be completely dispensed with. In this case, fresh air can be blown into the

pressure spaces 6, 7, 6′, 7′ of the cooler, this fresh air striking the objects 19, 19′ to be cooled in the useful spaces 14, 14′. The air heated thereby is sucked out via the floor ducts 20, 21, 20′, 21′ and led via the vertical connecting conduits 22, 23, 22′, 23′, now serving as exhaust shafts, to a fan which conveys the air either into the atmosphere or else feeds it completely or partially to a following zone or other facilities.

If the fresh air is very cold, it may also be necessary in special cases, for the purpose of achieving a desired air temperature, to provide in the cooler a heating device which warms up the fresh air accordingly.